CLAIMS

1. An image processing apparatus comprising:

a contrast improvement unit operable to perform a contrast improvement
process on an input image by comparing an object pixel of the input image
with pixels that belong to surrounding areas of the object pixel;

an image combination unit operable to combine an enhanced image
obtained by the contrast improvement unit and the input image; and

an image output unit operable to output the image after combination.

2. The image processing apparatus of claim 1 wherein

the contrast improvement unit comprises: a correction data calculation
unit operable to find a contrast improvement amount for a pixel in the
input image; an extraction unit operable to extract an effective range
from distribution of the contrast improvement amount; and a pixel value
conversion unit operable to convert a contrast improvement amount of the
object pixel to a value of a corresponding pixel in the enhanced image
according to the extracted range.

3. The image processing apparatus of claim 1 wherein

the contrast improvement unit comprises: a correction data calculation
unit operable to find a contrast improvement amount by comparing the object
pixel with pixels that belong to each of surrounding areas with different
sizes; an extraction unit operable to extract an effective range from
distribution of the contrast improvement amount; and a pixel value
conversion unit operable to convert a contrast improvement amount of the
object pixel to a value of a corresponding pixel in the enhanced image
according to the extracted range.

4. The image processing apparatus of claim 2 or 3 wherein

87

the pixel value conversion unit comprises: an average brightness calculation unit operable to calculate an average brightness of pixels in the input image; a conversion method selection unit operable to select a method of converting a contrast improvement amount to a value of pixel

5   in the enhanced image based on the average brightness; and a pixel value estimation unit operable to convert the contrast improvement amount to a value of pixel in the enhanced image according to the selected conversion method.

10   5. The image processing apparatus of claim 2 or 3 wherein

the pixel value conversion unit comprises: a standard intensity calculation unit operable to calculate a standard intensity value that indicates contrast intensity of the input image; a conversion curve estimation unit operable to estimate a conversion curve for converting

15   the contrast improvement amount to a value in the enhanced image based on the standard intensity value; and a pixel value estimation unit operable to use the conversion curve to convert the contrast improvement amount to a value in the enhanced image.

20   6. The image processing apparatus of claim 5 wherein

the conversion curve estimation unit comprises: an initial candidate setting unit operable to set an initial population of search vectors that indicate conversion curves; a pixel value conversion candidate calculation unit operable to find a conversion value in a candidate for an enhanced

25   image from the contrast improvement amount using a conversion curve candidate corresponding to each search vector; an evaluation value calculation unit operable to use the standard intensity value and the conversion value to calculate an evaluation value for evaluating the candidates of each conversion curve; a fitness calculation unit operable

30   to calculate fitness of a candidate of each conversion curve based on the

evaluation value; a recombination operation unit operable to perform recombination operation on a search vector selected based on the fitness of the candidates of each conversion curve and generate a next generation population; and an estimation end judgment unit operable to determine whether or not estimation of the conversion curve ends at a current generation.

7. The image processing apparatus of claim 1 wherein the contrast improvement unit comprises: a signal conversion unit operable to convert a value of pixel in the input image to a plurality of signals that include a signal that is an object of contrast improvement; an object correction data calculation unit operable to find a contrast improvement amount of the object pixel for an object signal obtained from the signal conversion unit; an extraction unit operable to extract an effective range from distribution of the contrast improvement amount for the object signal; an object signal conversion unit operable to convert the contrast improvement amount for the object signal to a value of the object signal in the enhanced image; and a signal inverse conversion unit operable to find a value of pixel in the enhanced image based on the object signal of the enhanced image and signals other than the object signal obtained by the signal conversion unit.

8. The image processing apparatus of claim 1 wherein the contrast improvement unit comprises: a signal conversion unit operable to convert a value of pixel in the input image to a signal that is an object of contrast improvement; an object correction data calculation unit operable to find a contrast improvement amount by comparing the object signal of the object pixel with the object signals of pixels that belong to each of surrounding areas with different sizes; an extraction unit operable to extract an effective range from distribution of the contrast

89

improvement amount for the object signal; an object signal conversion unit operable to convert a contrast improvement amount for the object signal to a value of the object signal in the enhanced image based on the extracted range; and a signal inverse conversion unit operable to find a value of pixel in the enhanced image based on the object signal of the enhanced image and signals other than the object signal obtained by the signal conversion unit.

9. The image processing apparatus of claim 7 or claim 8 wherein the object signal conversion unit comprises: an average object signal calculation unit operable to calculate an average value of the object signal in the input image; a conversion method selection unit operable to select a conversion method for converting the contrast improvement amount for the object signal to a value of the object signal in the enhanced image based on the average value; and an object signal estimation unit operable to convert the contrast improvement amount for the object signal to the value of the object signal in the enhanced image according to the selected conversion method.

10. The image processing apparatus of claim 7 or 8 wherein the object signal conversion unit comprises: a standard intensity calculation unit operable to calculate a standard intensity value that indicates contrast intensity of the input image for the object signal obtained by the signal conversion unit; an object signal conversion curve estimation unit operable to estimate a conversion curve for converting the contrast improvement amount for the object signal to the value in the enhanced image based on the standard intensity value; and an object signal estimation unit operable to use the estimated conversion curve to convert the contrast improvement amount for the object signal to the value in the enhanced image.

11. The image processing apparatus of claim 10 wherein

the object signal conversion curve estimation unit comprises: an initial candidate setting unit operable to set an initial population of search vectors that indicate conversion curves; an object signal conversion candidate calculation unit operable to find a conversion value for the object signal in a candidate for an enhanced image from the contrast improvement amount for the object signal using a conversion curve candidate corresponding to each search vector; an evaluation value calculation unit operable to use the standard intensity value and the conversion value to calculate an evaluation value for evaluating the candidates of each conversion curve; a fitness calculation unit operable to calculate fitness of a candidate of each conversion curve based on the evaluation value; a recombination operation unit operable to perform recombination operation on a search vector selected based on the fitness of the candidates of each conversion curve and generate a next generation population; and an estimation end judgment unit operable to determine whether or not estimation of the conversion curve ends at current generation.

12. The image processing apparatus of claim 1 wherein

the image combination unit comprises: a selection standard judgment unit operable to determine whether the input image or enhanced image has priority; a combination coefficient calculation unit operable to set combination coefficients for the input image and enhanced image based on the judgment of the selection standard judgment unit; and a weighted average combination unit operable to use the combination coefficients set for each image to generate a weighted average image of the input image and enhanced image.

13. An image processing apparatus comprising:

a contrast improvement unit operable to perform a contrast improvement process on an input image by comparing an object pixel of the input image with pixels that belong to surrounding areas of the object pixel;

an edge data detection unit operable to detect edge data of the input
5   image;

an image combination unit operable to combine an enhanced image obtained by the contrast improvement unit with the input image based on the edge data obtained by the edge data detection unit; and

an image output unit operable to output an image after combination.
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14. The image processing apparatus of claim 13 wherein

the contrast improvement unit comprises: a correction data calculation unit operable to find a contrast improvement amount for a pixel in the input image; an extraction unit operable to extract an effective range
15   from distribution of the contrast improvement amount; and a pixel value conversion unit operable to convert a contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

20   15. The image processing apparatus of claim 13 wherein

the contrast improvement unit comprises: a correction data calculation unit operable to find the contrast improvement amount by comparing the object pixel with pixels that belong to each of surrounding areas with different sizes; an extraction unit operable to extract an effective range
25   from distribution of the contrast improvement amount; and a pixel value conversion unit operable to convert a contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

30   16. The image processing apparatus of claim 13 wherein

92

the image combination unit comprises: a combination coefficient calculation unit operable to calculate combination coefficients for the input image and enhanced image based on the edge data obtained from the input image; and a weighted average combination unit operable to generate

5   a weighted average image for the input image and enhanced image based on the combination coefficients calculated for each image.

17. An image processing apparatus comprising:

a contrast improvement unit operable to perform a contrast improvement

10   process on an input image by comparing an object pixel in the input image with pixels that belong to surrounding areas of the object pixel;

a density correction unit operable to correct density distribution of an enhanced image obtained by the contrast improvement unit according to density distribution of the input image;

15   an image combination unit operable to combine a corrected image obtained by the density correction unit and the input image; and

an image output unit operable to output an image after combination.

18. The image process apparatus of claim 17 wherein

20   the image combination unit comprises: a weighted average combination unit operable to generate a weighted average image for the input image and enhanced image; and an output value setting unit operable to set a value of pixel in an output image based on the image obtained by the weighted average combination unit and the input image.

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19. An image processing apparatus comprising:

an edge data detection unit operable to detect edge data of an input image;

a contrast improvement unit operable to perform a contrast improvement

30   process on the input image by determining an area where an object pixel

93

belongs based on the edge data of the object pixel obtained by the edge data detection unit and brightness of the object pixel, and by comparing the object pixel with pixels that belong to surrounding areas of the object pixel;

5   an image combination unit operable to combine an enhanced image obtained by the contrast improvement unit and the input image; and

an image output unit operable to output an image after combination.

20. The image processing apparatus of claim 19 wherein

10   the image combination unit comprises: a weighted average combination unit operable to generate a weighted average image for the input image and enhanced image; and an output value setting unit operable to set a value of pixel in the output image based on the image obtained by the weighted average combination unit and the input image.

15

21. An image processing apparatus comprising:

an edge data detection unit operable to extract edge data of an input image;

a contrast improvement unit operable to perform a contrast improvement

20   process on the input image by determining an area where an object pixel belongs based on the edge data of the object pixel obtained by the edge data detection unit and brightness of the object pixel, and by comparing the object pixel with pixels that belong to surrounding areas of the object pixel;

25   an image combination unit operable to combine an enhanced image obtained by the contrast improvement unit and the input image based on the edge data obtained by the edge detection unit; and

an image output unit operable to output an image after combination.

30   22. The image processing apparatus of claim 19 or claim 21 wherein

94

the contrast improvement unit comprises: an area judgment unit operable to determine an area where the object pixel belongs based on edge data; a comparison range setting unit operable to select a pixel comparison range based on the area obtained by the area judgment unit; a correction

5   data calculation unit operable to find a contrast improvement amount for the object pixel based on the pixel comparison range selected by the comparison range setting unit; an adjustment coefficient calculation unit operable to calculate an adjustment coefficient for the contrast improvement amount based on the area obtained by the area judgment unit;

10   an adjustment unit operable to correct the contrast improvement amount using the adjustment coefficient obtained by the adjustment coefficient calculation unit; an extraction unit operable to extract an effective range from distribution of the corrected contrast improvement amount; and a pixel value conversion unit operable to convert the contrast improvement amount

15   of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

       23. The image processing apparatus of claim 19 or claim 21 wherein the contrast improvement unit comprises: an area judgment unit

20   operable to determine an area where the object pixel belongs based on the edge data; a correction data calculation unit operable to find a contrast improvement amount by comparing the object pixel with a pixel that belongs to each of surrounding areas having different sizes; an adjustment coefficient calculation unit operable to calculate an adjustment

25   coefficient for the contrast improvement amount based on the area obtained by the area judgment unit; an adjustment unit operable to correct the contrast improvement amount using the adjustment coefficient obtained by the adjustment coefficient calculation unit; an extraction unit operable to extract an effective range from distribution of the corrected contrast

30   improvement amount; and a pixel value conversion unit operable to convert

the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

24. An image processing apparatus comprising:

5   a contrast improvement unit having a correction data calculation density binding unit operable to bind density of a pixel in an area surrounding an object pixel in an input image, wherein the contrast improvement unit performs a contrast improvement process on the input image in the bound state by comparing the object pixel of the input image with
10   pixels of the surrounding area; and

an image output unit operable to output an enhanced image obtained by the contrast improvement unit.

25. An image processing apparatus comprising:

15   a contrast improvement unit having a correction data calculation density binding unit operable to bind density of a pixel in an area surrounding an object pixel in an input image, wherein the contrast improvement unit performs a contrast improvement process on the input image in the bound state by comparing the object pixel of the input image with
20   pixels of the surrounding area;

an image combination unit operable to combine an enhanced image obtained by the contrast improvement unit and the input image; and

an image output unit operable to output an image after combination.

25   26. The image processing apparatus of claim 24 or claim 25 wherein the contrast improvement unit comprises: a correction data calculation unit operable to find a contrast improvement amount of the object pixel; an extraction unit operable to extract an effective range from distribution of contrast; and a pixel value conversion unit operable to convert the
30   contrast improvement amount of the object pixel to a value of corresponding

pixel in the enhanced image.

27. The image processing apparatus of claim 24 or claim 25 wherein the contrast improvement unit comprises: a correction data calculation unit operable to find a contrast improvement amount by comparing the object pixel with pixels that belong to each of surrounding areas with different sizes; an extraction unit operable to extract an effective range from distribution of the contrast improvement amount; and a pixel value conversion unit operable to convert the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image.

28. An image processing apparatus comprising:
a pre-processing unit operable to perform pre-processing on an input image;
a contrast improvement unit operable to perform a contrast improvement process on the pre-processed image by comparing an object pixel of the pre-processed image with pixels that belong to surrounding areas of the object pixel;
an image combination unit operable to combine an enhanced image obtained by the contrast improvement unit and the input image;
a post-processing unit operable to perform post-processing on an image after combination; and
an image output unit operable to output the post-processed image.

29. The image processing apparatus of claim 28 wherein the contrast improvement unit comprises: a comparison pixel setting unit operable to set comparison pixels from among pixels in the area surrounding the object pixel to be used in the comparison; a correction data calculation unit operable to find a contrast improvement amount of the object pixel; a conversion standard value calculation unit operable

to find a conversion standard value for converting the contrast improvement amount to a value of pixel in the enhanced image; and a pixel value conversion unit operable to convert the contrast improvement amount to a value of pixel in the enhanced image based on the conversion standard value.

30. The image processing apparatus of claim 29 wherein

the correction data calculation unit comprises: a surrounding average unit operable to find a weighted average for density of the comparison pixels; and an improvement amount calculation unit operable to find a contrast improvement amount from the average density obtained by the surrounding average unit and density of the object pixel.

31. The image processing apparatus of claim 29 wherein

the correction data calculation unit comprises: a surrounding average unit operable to find a weighted average for density of the comparison pixels; an edge data detection unit operable to detect edge data of the object pixel; a correction coefficient calculation unit operable to calculate a correction coefficient for the edge data based on the edge data obtained by the edge data detection unit; a comparison amount correction unit operable to correct the average density obtained by the surrounding average unit using the correction coefficient; and an improvement · amount calculation unit operable to find a contrast improvement amount from the corrected average density and the density of the object pixel.

32. The image processing apparatus of claim 29 wherein

the correction data calculation unit comprises: a surrounding average unit operable to find a weighted average for density of the comparison pixels; an improvement amount calculation unit operable to find a contrast

improvement amount from the average density obtained by the surrounding
average unit and the density of the object pixel; an enhancement component
calculation unit operable to calculate an enhancement component from
difference in the density of the comparison pixel and the object pixel;
5   and an improvement amount correction unit operable to add the enhancement
component to the contrast improvement amount.

33. The image processing apparatus of claim 28 wherein
the contrast improvement unit comprises: a comparison pixel setting
10   unit operable to set positions in a vertical direction of pixels to be
used in the comparison from among pixels in the area surrounding the object
pixel; a vertical direction addition unit operable to add weighting in
the vertical direction to the density of the comparison pixels obtained
by the comparison pixel setting unit; a simple surrounding average unit
15   operable to calculate comparison density for the object pixel from a value
at each horizontal pixel position in the surrounding area obtained by the
vertical direction addition unit; an improvement amount calculation unit
operable to find a contrast improvement amount from the comparison density
and density of the object pixel; a conversion standard value calculation
20   unit operable to find a conversion standard value for converting the
contrast improvement amount to a value of pixel in the enhanced image;
and a pixel value conversion unit operable to convert the contrast
improvement amount to a value of pixel in the enhanced image based on the
conversion standard value.

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34. The image processing apparatus of claim 28 wherein
the contrast improvement unit comprises: a comparison pixel setting
unit operable to set positions in a vertical direction and positions in
a horizontal direction of pixels to be used in the comparison from among
30   pixels in the area surrounding the object pixel ; a removal vertical

direction addition unit operable to add weighting to the vertical direction of the density of the comparison pixels obtained by the comparison pixel setting unit; a simple surrounding average unit operable to calculate comparison density for the object pixel based on an addition value obtained

5 by the removal vertical direction addition unit; an improvement amount calculation unit operable to find a contrast improvement amount from the comparison density and density of the object pixel; a conversion standard value calculation unit operable to find a conversion standard value for converting the contrast improvement amount to a value of pixel in the

10 enhanced image; and a pixel value conversion unit operable to convert the contrast improvement amount to a value of pixel in the enhanced image based on the conversion standard value.

35. The image processing apparatus of claim 28 wherein

15 the pre-processing unit performs inverse conversion of gamma conversion on the input image in advance.

36. The image processing apparatus of claim 35 wherein the post-processing unit performs the gamma conversion.

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37. The image processing apparatus of claim 28 wherein the post-processing unit comprises: an input brightness/color calculation unit operable to calculate a brightness value and color difference components of the input image; a brightness adjustment unit

25 operable to compare a brightness component of the input image obtained by the input brightness/color calculation unit with the brightness component of a combined image and adjust the brightness component of the combined image; a color component correction unit operable to correct the color difference components of the input image obtained by the input

30 brightness/color calculation unit based on the brightness component of

100

the combined image obtained by the brightness adjustment unit; an image regeneration unit operable to regenerate the combined image using the brightness component of the combined image obtained by the brightness adjustment unit and the corrected color difference components obtained

5   by the color component correction unit; and a gamma conversion unit operable to perform gamma conversion on the combined image obtained by the image regeneration unit.

38. An image processing method comprising:

10   a contrast improvement step of performing a contrast improvement process on an input image by comparing an object pixel of the input image with pixels that belong to surrounding areas of the object pixel;

an image combination step of combining an enhanced image obtained from the contrast improvement unit and the input image; and

15   a step of outputting an image after combination.

39. The image processing method of claim 38 wherein

the contrast improvement step comprises: a step of finding a contrast improvement amount for a pixel in the input image; a step of extracting

20   an effective range from distribution of the contrast improvement amount; and a pixel value conversion step of converting the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

25   40. The image processing method of claim 38 wherein

the contrast improvement step comprises: a step of finding a contrast improvement amount by comparing the object pixel with pixels that belong to each of surrounding areas with different sizes; a step of extracting an effective range from distribution of the contrast improvement amount;

30   and a pixel value conversion of converting the contrast improvement amount

101

of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

41. The image processing method of claim 39 or 40 wherein
the pixel value conversion step comprises: a step of calculating an average brightness of pixels in the input image; a step of selecting a method of converting the contrast improvement amount to a value of pixel in the enhanced image based on the average brightness; and a step of converting the contrast improvement amount to a value of pixel in the enhanced image according to the selected conversion method.

42. The image processing method of claim 39 or 40 wherein
the pixel value conversion step comprises: a step of calculating the standard intensity value that indicates contrast intensity of the input image; a conversion curve estimation step of estimating a conversion curve for converting the contrast improvement amount to a value in the enhanced image; and a step of using the conversion curve to convert the contrast improvement amount to a value in the enhanced image.

43. The image processing method of claim 42 wherein
the conversion curve estimation step comprises: a step of setting an initial population of search vectors that indicate conversion curves; a step of finding a conversion value in a candidate for an enhanced image from the contrast improvement amount using a conversion curve candidate corresponding to each search vector; a step of using the standard intensity value and the conversion value to calculate an evaluation value for evaluating the candidates of each conversion curve; a step of calculating fitness of a candidate of each conversion curve based on the evaluation value; a step of performing recombination operation on a search vector selected based on the fitness of the candidates of each conversion curve

102

and generating a next generation population; and a step of determining whether or not estimation of the conversion curve ends at current generation.

44. The image processing method of claim 38 wherein

5   the contrast improvement step comprises: a signal conversion step of converting a value of pixel in the input image to a plurality of signals that include the signal that is an object of contrast improvement; a step of finding a contrast improvement amount of the object pixel for an object signal obtained from the signal conversion step; a step of extracting an

10   effective range from distribution of the contrast improvement amount for the object signal; an object signal conversion step of converting the contrast improvement amount for the object signal to a value of the object signal in the enhanced image; and a step of finding a value of pixel in the enhanced image based on the object signal of the enhanced image and

15   signals other than the object signal obtained by the signal conversion step.

45. The image processing method of claim 38 wherein

the contrast improvement step comprises: a signal conversion step of

20   converting a value of pixel in the input image to a signal that is an object of contrast improvement; a step of finding a contrast improvement amount by comparing the object signal of the object pixel with the object signals of pixels that belong to each of surrounding areas with different sizes; a step of extracting an effective range from distribution of the contrast

25   improvement amount for the object signal; an object signal conversion step of converting the contrast improvement amount for the object signal to a value of the object signal in the enhanced image based on the extracted range; and a step of finding a value of pixel in the enhanced image based on the object signal of the enhanced image and signals other than the object

30   signal obtained by the signal conversion step.

46. The image processing step of claim 44 or claim 45 wherein

the object signal conversion step comprises: a step of calculating an average value of the object signal in the input image; a step of selecting

5   a conversion method for converting the contrast improvement amount for the object signal to a value of the object signal in the enhanced image based on the average value; and step of converting the contrast improvement amount for the object signal to a value of the object signal in the enhanced image according to the selected conversion method.

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47. The image processing method of claim 44 or 45 wherein

the object signal conversion step comprises: a step of calculating a standard intensity value that indicates contrast intensity of the input image for the object signal obtained by the signal conversion step; an

15   object signal conversion curve estimation step of estimating a conversion curve for converting the contrast improvement amount for the object signal to a value in the enhanced image; and a step of using the estimated conversion curve to convert the contrast improvement amount for the object signal to a value in the enhanced image.

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48. The image processing method of claim 47 wherein

the object signal conversion curve estimation step comprises: a step of setting an initial population of search vectors that indicate conversion curves; a step of finding conversion value for the object signal in a

25   candidate for an enhanced image from the contrast improvement amount for the object signal using a conversion curve candidate corresponding to each search vector; a step of using the standard intensity value and the conversion value to calculate an evaluation value for evaluating the candidates of each conversion curve; a step of calculating fitness of the

30   candidates of each conversion curve based on the evaluation value; a step

of performing recombination operation on a search vector selected based on the fitness of the candidates of each conversion curve and generating a next generation population; and a step of determining whether or not estimation of the conversion curve ends at current generation.

49. The image processing method of claim 38 wherein

the image combination step comprises: a selection standard judgment step of determining whether the input image or enhanced image has priority; a combination coefficient calculation step of setting combination coefficients for the input image and enhanced image based on the judgment of the selection standard judgment step; and a step of using the combination coefficients set for each image to generate a weighted average image of the input image and enhanced image.

50. An image processing method comprising:

a contrast improvement step of performing a contrast improvement process on an input image by comparing an object pixel of the input image with pixels that belong to surrounding areas of the object pixel;

an edge data detection step of detecting edge data of the input image;

an image combination step of combining an enhanced image obtained by the contrast improvement step with the input image based on the edge data obtained by the edge data detection step; and

a step of outputting an image after combination.

51. The image processing method of claim 50 wherein

the contrast improvement step comprises: a step of finding a contrast improvement amount for a pixel in the input image; a step of extracting an effective range from distribution of the contrast improvement amount; and a step of converting the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according

to the extracted range.

52. The image processing method of claim 50 wherein

the contrast improvement step comprises: a step of finding the contrast

5   improvement amount by comparing the object pixel with a pixel that belong

to each of surrounding areas of different sizes; a step of extracting an

effective range from distribution of the contrast improvement amount; and

a step of converting the contrast improvement amount of the object pixel

to a value of corresponding pixel in the enhanced image according to the

10   extracted range.

53. The image processing method of claim 50 wherein

the image combination step comprises: a step of calculating

combination coefficients for the input image and enhanced image based on

15   the edge data obtained from the input image; and a step of generating a

weighted average image for the input image and enhanced image based on

the combination coefficients calculated for each image.

54. An image processing method comprising:

20   a contrast improvement step of performing a contrast improvement

process on an input image by comparing an object pixel in the input image

with pixels that belong to surrounding areas of the object pixel;

a density correction step of correcting density distribution of an

enhanced image obtained by the contrast improvement step according to

25   density distribution of the input image;

a step of combining a corrected image obtained by the density

correction step and the input image; and

a step of outputting an image after combination.

30   55. The image process method of claim 54 wherein

106

the image combination step comprises: a weighted average combination step of generating a weighted average image for the input image and corrected image; and a step of setting a value of pixel in an output image based on the image obtained by the weighted average combination step and

5   the input image.

56. An image processing method comprising:

an edge data detection step of detecting edge data of an input image;

a contrast improvement step of performing a contrast improvement

10   process on the input image by determining an area where an object pixel belongs based on the edge data of the object pixel obtained by the edge data detection step and brightness of the object pixel, and by comparing the object pixel with pixels that belong to surrounding areas of the object pixel;

15   an image combination step of combining an enhanced image obtained by the contrast improvement step and the input image; and

a step of outputting an image after combination.

57. The image processing method of claim 56 wherein

20   the image combination step comprises: a weighted average combination step of generating a weighted average image for the input image and enhanced image; and a step of setting a value of pixel in the output image based on the image obtained by the weighted average combination step and the input image.

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58. The image processing method of claim 56 wherein

the contrast improvement step comprises: an area judgment step of determining an area where the object pixel belongs based on edge data; a comparison range setting step of selecting a pixel comparison range based

30   on the area obtained by the area judgment step; a step of finding a contrast

107

improvement amount for the object pixel based on the pixel comparison range

selected by the comparison range setting step; an adjustment coefficient

calculation step of calculating an adjustment coefficient for the contrast

improvement amount based on the area obtained by the area judgment step;

5   a step of correcting the contrast improvement amount using the adjustment

coefficient obtained by the adjustment coefficient calculation step; a

step of extracting an effective range from the corrected contrast

improvement amount; and a step of converting the contrast improvement

amount of the object pixel to a value of corresponding pixel in the enhanced

10   image according to the extracted range.

59. The image processing method of claim 56 wherein

the contrast improvement step comprises: an area judgment step of

determining an area where the object pixel belongs based on edge data;

15   a step of finding a contrast improvement amount by comparing the object

pixel with a pixel that belongs each of surrounding areas having different

sizes; an adjustment coefficient calculation step of calculating an

adjustment coefficient for the contrast improvement amount based on the

area obtained by the area judgment step; a step of correcting the contrast

20   improvement amount using the adjustment coefficient obtained by the

adjustment coefficient calculation step; a step of extracting an effective

range from the corrected contrast improvement amount; and a step of

converting the contrast improvement amount of the object pixel to a value

of corresponding pixel in the enhanced image according to the extracted

25   range.

60. An image processing method comprising:

a contrast improvement step of performing a contrast improvement

process, in a state that density of a pixel in an area surrounding an object

30   pixel in an input image is bound, on the input image by comparing the object

108

pixel of the input image with a pixel of the surrounding area; and

a step of outputting an enhanced image obtained by the contrast improvement step.

5   61. An image processing method comprising:

a contrast improvement step of performing a contrast improvement process, in a state that density of a pixel in an area surrounding an object pixel in an input image is bound, on the input image by comparing the object pixel of the input image with a pixel of the surrounding area;

10   a step of combining an enhanced image obtained by the contrast improvement step and the input image; and

a step of outputting an image after combination.

62. The image processing method of claim 60 or claim 61 wherein

15   the contrast improvement step comprises: a step of finding a contrast improvement amount of the object pixel; a step of extracting an effective range from distribution of contrast; and a step of converting the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image.

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63. The image processing method of claim 60 or claim 61 wherein

the contrast improvement step comprises: a step of finding a contrast improvement amount by comparing the object pixel with pixels that belong to each of surrounding areas with different sizes; a step of extracting

25   an effective range from distribution of the contrast improvement amount; and a step of converting the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image.

64. An image processing method comprising:

30   a pre-processing step of performing pre-processing on an input image;

109

a contrast improvement step of performing a contrast improvement process on the pre-processed image by comparing an object pixel of the pre-processed image with pixels that belong to surrounding areas of the object pixel;

5   a step of combining an enhanced image obtained by the contrast improvement step and the input image;

a post-processing step of performing post-processing on an image after combination; and

a step of outputting the post-processed image.

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65. The image processing method of claim 64 wherein

the contrast improvement step comprises: a step of setting a comparison pixel from among pixels in the area surrounding the object pixel to be used in the comparison; a correction data calculation step of finding a

15   contrast improvement amount of the object pixel; a step of finding a conversion standard value for converting the contrast improvement amount to a value of pixel in the enhanced image; and a step of converting the contrast improvement amount to a value of pixel in the enhanced image based on the conversion standard value.

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66. The image processing method of claim 65 wherein

the correction data calculation step comprises: a surrounding average step of finding a weighted average for density of the comparison pixels; and a step of finding a contrast improvement amount from the average density

25   obtained by the surrounding average step and density of the object pixel.

67. The image processing method of claim 65 wherein

the correction data calculation step comprises: a surrounding average step of finding a weighted average for the density of the comparison pixels;

30   an edge data detection step of detecting edge data of the object pixel;

110

a step of calculating a correction coefficient for the edge data based on the edge data obtained by the edge data detection step; a step of correcting the average density obtained by the surrounding average step using the correction coefficient; and a step of finding a contrast
5   improvement amount from the corrected average density and the density of the object pixel.

68. The image processing method of claim 65 wherein

the correction data calculation step comprises: a surrounding average
10   step of finding a weighted average for density of the comparison pixels; a step of finding a contrast improvement amount from the average density obtained by the surrounding average step and the density of the object pixel; a step of calculating an enhancement component from difference in the density of the comparison pixel and the object pixel; and a step of
15   adding the enhancement component to the contrast improvement amount to correct the contrast improvement amount.

69. The image processing method of claim 64 wherein

the contrast improvement step comprises: a step of setting positions
20   in a vertical direction of pixels to be used in the comparison from among pixels in the area surrounding the object pixel; a vertical direction addition step of adding weighting in the vertical direction to the density of the comparison pixels obtained by the setting; a step of calculating comparison density for the object pixel from a value at each horizontal
25   pixel position in the surrounding area obtained by the vertical direction addition step; a step of finding a contrast improvement amount from the comparison density and density of the object pixel; a step of finding a conversion standard value for converting the contrast improvement amount to a value of pixel in the enhanced image; and a step of converting the
30   contrast improvement amount to a value of the pixel in the enhanced image

111

based on the conversion standard value.

70. The image processing method of claim 64 wherein
the contrast improvement step comprises: a step of setting positions
in a vertical direction and positions in a horizontal direction of pixels
to be used in the comparison from among pixels in the area surrounding
the object pixel; a removal vertical direction addition step of adding
weighting to the vertical direction of the density of the comparison pixels
obtained by the setting; a step of calculating comparison density for the
object pixel based on an addition value obtained by the removal vertical
direction addition step; a step of finding a contrast improvement amount
from the comparison density and density of the object pixel; a step of
finding a conversion standard value for converting the contrast
improvement amount to a value of pixel in the enhanced image; and a step
of converting the contrast improvement amount to a value of pixel in the
enhanced image based on the conversion standard value.

71. The image processing method of claim 64 wherein
the pre-processing performs inverse conversion of gamma conversion
on the input image in advance.

72. The image processing method of claim 64 wherein
the post-processing performs gamma conversion.

73. The image processing method of claim 64 wherein
the post-processing step comprises: an input brightness/color
calculation step of calculating a brightness value and color difference
components of the input image; a brightness adjustment step of comparing
a brightness component of the input image obtained by the input
brightness/color calculation step with the brightness component of a

112

combined image and adjusting the brightness component of the combined

image; a color component correction step of correcting the color difference

components of the input image obtained by the input brightness/color

calculation step based on the brightness component of the combined image

5   obtained by the brightness adjustment step; an image regeneration step

of regenerating the combined image using the brightness component of the

combined image obtained by the brightness adjustment step and the corrected

color difference components obtained by the color component correction

step; and a step of performing gamma conversion on the combined image

10   obtained by the image regeneration step.